Research on the Trend and Application of Human–Computer Interaction Product Design under the Trend of Artificial Intelligence

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Abstract: As artificial intelligence technology matures, human-computer interaction is transitioning from "graphical user interfaces" to "natural intelligent interaction." This paper explores innovations in interaction methods, technical approaches, and emotional experiences of human-computer interaction products under AI trends. It analyzes the impact of AI on future design trends in human-computer interaction products and summarizes the strategies and directions of AI technology in their design. Addressing current challenges in human-computer interaction product design, the paper proposes strategies from the perspectives of user emotional needs and privacy security, offering recommendations to advance the development of human-computer interaction products.

Keywords: Artificial Intelligence; Design Trends; Product Design; Human-Computer Interaction

1. Introduction

We are currently in a period of explosive growth in artificial intelligence technology. Generative AI systems like the GPT series and Stable Diffusion, along with mature computer vision and speech recognition technologies, are fundamentally redefining the rules of human-computer interaction. The traditional WIMP paradigm (Windows, Icons, Menu, Pointer) centered on mouse, keyboard, and touchscreens has shown its limitations in handling increasingly complex information and pursuing optimal user experiences. The focus of human-computer interaction (HCI) research and practice is shifting from "how to make machines operate more efficiently" to "how to enable machines to understand and serve humans more naturally." In this context, exploring new paradigms and methods for designing HCI products under AI trends not only holds practical value for enhancing user experience and unlocking technological dividends, but also carries significant theoretical importance for enriching design theory and clarifying the core competencies required of future designers.

2. Overview of Design Artificial Intelligence and Intelligent Human-Computer Interaction

2.1 Designing Artificial Intelligence

Design Artificial Intelligence (DAI or D+AI) is a branch of artificial intelligence that applies AI methodologies to develop theories, methods, and technologies for creative design simulation, design extension, and design expansion. It also encompasses application systems such as graphic design, 3D design, and dynamic media design [1]. Human-computer interaction (HCI) refers to the information exchange process between humans and computers through specific languages and interactive forms to accomplish tasks. HCI design focuses on the interaction between systems (machines) and users (people). By studying users' psychological needs and emotional levels during system operation, it designs human-machine interaction behaviors to demonstrate effective human-computer interaction functions.

2.2 Intelligent Human-Machine Interaction

Intelligent human-computer interaction refers to the interaction between human users and AI-powered systems. As a product of the convergence between artificial intelligence and human-computer interaction technologies, it enhances the naturalness and effectiveness of interactions compared to traditional methods. Currently, this technology is widely applied in fields such as autonomous driving, healthcare, education, robotics, and smart home systems [2]. Intelligent human-machine interaction products are devices equipped with sensing, memory, and

computational capabilities, enabling physical and informational communication with humans, other smart devices, and the environment. These products are increasingly becoming part of daily life and are poised to significantly influence or even transform human behavior and lifestyles in the future. Meanwhile, the growth of the digital economy and rising consumption standards have shifted user focus toward delivering exceptional experiences during consumption. Thus, conducting user experience research to ensure these products meet actual user needs is of paramount importance [8].

3. The Influence of Artificial Intelligence on Human-computer Interaction Product Design and Its Core Features

3.1 The Transformation of Interaction Methods

Traditional interaction relies on explicit user instructions. The introduction of artificial intelligence technologies, particularly natural language understanding and contextual awareness, has made "dialogue" the core interaction mode. Users can express their needs using vague, conversational language. Additionally, multimodal fusion has become a common approach.

3.2 Technological Leap

The systematic leap in technical capabilities has charted a clear evolutionary path for human-computer interaction to transition from instrumental collaboration to emotional connection. Early human-computer interactions (e.g., ELZA) were fundamentally designed as template-driven efficiency tools constrained by technological limitations, capable only of handling specific scenarios and structured inputs. In the early 21st century, virtual assistants like Siri and Echo enhanced natural language understanding but still revealed the inherent conflict between mechanical responses and evolving human needs. This prompted a technological shift toward achieving deep semantic understanding and stylistic responses. The 2017 introduction of the Transformer architecture marked a pivotal turning point, unlocking new technical possibilities for "emotional connection." Subsequently, bidirectional encoder representations from transformers (BERT) enabled dynamic modeling of contextual semantics, while large models like GPT-3 sparked the explosive growth of generative AI. Particularly in 2022, the emergence of ChatGPT redefined interaction logic. Its core breakthrough lies in pre-trained massive-parameter models that precisely capture complex human language patterns, combined with reinforcement learning models (RL-HF) incorporating human feedback, enabling machines to deliver more reliable and flexible "stylistic responses." When users express emotions, the model can prioritize strategies such as soothing or empathy based on human interaction patterns. This signifies that human-computer interaction has officially transitioned from 'semantic understanding' to a new phase of 'emotional intent recognition,' thereby fostering the commercial prosperity of specialized emotional interaction services like Replika and Soul.

3.3 Expansion of Design Object

The widespread adoption of artificial intelligence technology has transformed human-computer interaction products from mere operational objects into intelligent agents with perception, reasoning, and feedback capabilities. This evolution requires design thinking to shift focus from shaping physical forms to defining the behavior, personality, and social relationships of these agents. For instance, should in-car voice assistants possess a sense of humor? When is it appropriate to interrupt users? These questions fall under the domains of anthropomorphic design and social interaction. Meanwhile, the black-box nature of intelligent agents poses trust challenges, making transparent decision-making processes through design a new critical issue.

3.4 Core Design Features

Based on the aforementioned research and analysis, four core characteristics of human-computer interaction (HCI) product design trends under AI technology can be identified: First, predictability and proactivity. By anticipating user needs and behaviors in advance and proposing tailored solutions, this approach achieves tacit understanding through interactive experiences. Second, non-adaptive and personalized features. AI advancements have driven personalized interaction development. Machine learning and big data analytics enable deep insights into user preferences and behavioral patterns, delivering

customized services and recommendations. Personalized interaction methods significantly enhance user satisfaction and loyalty while providing more convenient and efficient experiences. Third, implicit and seamless interaction. This refers to triggered interactions within predefined scenarios rather than passive responses, moving beyond traditional question-and-answer formats. Fourth, cross-device and multimodal interaction. The widespread adoption of smart devices has made cross-device collaboration and multimodal interaction critical trends in HCI product design. Cross-device collaboration enables seamless integration and resource sharing across devices, offering smarter home experiences. For instance, smartphones and smart speakers can be controlled via voice assistants for synchronized operations, creating intelligent home environments. Simultaneously, multimodal interaction enriches HCI products by combining visual, auditory, and tactile senses, enabling immersive user experiences [3].

4. Trends and Approaches in Human-Machine Interaction Product Design Based on Artificial Intelligence Technology

4.1 Emotionally-Focused Design with Human-Machine Integration

At present, design artificial intelligence has been developed in different fields. As a design and development tool, design artificial intelligence is the collaborator and manager of human-computer interaction designers. The integration of emotional design makes human-computer interaction design more humanized and intelligent, and becomes an indispensable new intelligent product in people's daily life.

With the continuous advancement of design artificial intelligence technology and the refinement of human-computer interaction design theory, interactive products are increasingly focusing on the "user experience" and "user emotion" modules. Research on emotional design has expanded possibilities for creating AI-powered interactive products. To develop interaction models that deeply integrate human wisdom with machine intelligence, designers must pursue higher, faster, and stronger intelligent responses while providing ample flexibility for human-computer interaction. By combining emotion with creativity, systems can become more compassionate and warm[2]. The wave of design AI enables users to explore broader spiritual dimensions from a higher perspective, while emotional design transforms AI into a reliable material form in human society, making machines invisible explorers of social discovery[8].

4.2 Immersion and Multimodal Natural Interaction

Seamless interaction, also known as invisible interaction or unobtrusive interaction, represents a user experience design philosophy and advanced interaction paradigm. Its core objective is to enable users to achieve goals efficiently and smoothly without consciously focusing on the "interaction" itself, allowing technology and services to seamlessly integrate into their workflows and scenarios. The essence of seamless interaction lies in minimizing visible operational interfaces. Physical control terminals should gradually be replaced by spatial interactions [6]. For instance, the core concept of NIO's NOMI's seamless natural interaction design is "Know Me" – through scene perception, proactive services, natural dialogue, and emotional connection, technology becomes invisible. NOMI's key capability lies in proactively providing services based on different driving scenarios rather than waiting for user commands. NOMI demonstrates moderate control over when to intervene proactively and when to grant users independent space, adopting a human-centered approach. Through emotionally engaging, multimodal, and seamlessly integrated design, it creates truly natural, fluid, and unobtrusive experiences. In today's era of ubiquitous smart devices, seamless interaction is not only a technological pursuit but also the ultimate goal of user experience.

Therefore, during product development, designers should focus on users 'latent needs for human-computer interaction products. These needs are often unexpressed by users themselves but are crucial for enhancing overall user experience. After identifying these needs, designers can leverage the interactive features of artificial intelligence to analyze product functionalities and interaction elements, completing steps such as knowledge representation and processing, knowledge reasoning and decision-making, and knowledge

learning and updating. This process helps determine which features can meet the corresponding needs of product development. Once product functions are defined, designers should then comprehensively design the product's appearance and internal structure, enhancing the interface design from a user-centric perspective. Improvements should be made in color, material, and craftsmanship to refine the product's visual texture and emotional experience through CMF analysis [2].

4.3 Product Safety and Privacy Protection

The widespread adoption of personalized human-computer interaction products has brought privacy concerns to the forefront. As users engage with these systems, growing apprehensions about personal data breaches are eroding trust in both products and their underlying mechanisms. While delivering tailored services, such products require users to provide specific data. Therefore, designers should refine how users access, control, and opt for personal information during product development and promotion. This approach empowers users to make informed choices and assert their agency, while reducing perceived coercion in data disclosure to mitigate privacy risks [7].

4.4 Careful Design in Human-Computer Interaction

Advances in human-computer intelligent interaction technology have not only enhanced user experience for general consumers but also opened new avenues for exploring the world for special populations. The evolution of human-computer interaction has transformed lives for vulnerable groups. A prime example is Dawn Verβ, a café in Tokyo, Japan, designed by designer Yoshitaka Yoshimoto for people with ALS. This innovative setup allows individuals with physical disabilities to remotely control virtual avatars, essentially providing them with an "alternative body" that breaks down physical barriers. For those facing mobility challenges, the "OriHime" virtual assistant offers a "second body" through remote operation, enabling tasks like home visits and meal delivery. To address communication barriers, the interface supports eye-tracking and head control, allowing even users with limited eye movement to interact. The robot's built-in camera, microphone, and speaker extend users' sensory perception, creating an interactive "blank canvas" where operators can customize avatars with virtual identities (including gender-swapping or non-human transformations), empowering them to express their "ideal selves" more freely. This project has generated over 60 job opportunities, with participants earning hourly wages exceeding Japan's minimum wage, achieving dignified economic participation. The revolution in human-computer interaction technology is reshaping inclusive design paradigms, shifting from "compensating for deficiencies" to "creating possibilities" [5]. It reminds us that technology can become a "mental wheelchair". However, the widespread adoption of this model faces challenges, including high technical costs, reliance on stable network environments, and new ethical and legal issues like the delineation of responsibilities in remote work mentioned earlier. Therefore, in this era of advancing artificial intelligence, designers should take responsibility and adopt a more compassionate design approach, ensuring AI technology does not remain a cold auxiliary tool.

5. Conclusion

Artificial intelligence (AI) technology has revolutionized modern human-computer interaction (HCI) product design, significantly expanding interaction methods and enhancing user experience. Future HCI products will become more intelligent and personalized. Designers must now prioritize user emotions and privacy considerations in product development to better align with user needs. As technology continues to mature, AI will play an increasingly pivotal role in HCI innovation, driving the industry toward smarter and more human-centric solutions.

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